METEOROLOGICAL OFFICE
130823
16 NOV 1979
C
LIBRARY

RESTRICTED CIRCULATION

This paper is not an official document; it is for information only and must not be quoted in any printed publication.

AGRICULTURAL MEMORANDUM NO. 866

STRAW BURNING - METEOROLOGICAL EFFECTS

J B Tyldesley

This is a subject on which queries sometimes arise at harvest time. Ride (1965) is a useful article, which includes an estimate of heat output from one fire (about 9 MW).

Lee (1974) is another article about straw burning on downland. The author was probably unaware of Ride's work, and specifically mentioned that in the instance of cumulus formation over a straw fire which he saw, ".... no obvious source of water was available to assist the cloud forming process ...."

The present author wrote to Weather, pointing out that the burning process itself releases water vapour, and that the amount may be estimated. Since the letter was not published, the calculations are given below.

An acre (about $4 \times 10^7 cm^2$) of short-strawed barley grown on chalk land, may produce about 1 ton (10^6 grams) of straw. It consists of 15% water and 85% dry matter, mostly carbohydrates of empirical formula $C_{12}H_{22}O_{11}$. When oxidised by burning the dry matter produces water to the extent of 58% of the original weight, plus carbon dioxide and a little ash which do not concern us. Thus 1 ton of straw produces $0.15 + (0.85 \times 0.58) = 0.64$ ton of water.

Does this amount of water significantly increase the atmospheric water vapour? In Lee's case, there was an inversion at 910 mb (say 1000 m), not untypical of summer conditions. Suppose that there is no horizontal wind, and that convection mixes this additional water uniformly up to the inversion. It fills a box of base 1 acre and height 1000 m, volume therefore $4 \times 10^6 m^3$. This gives an additional vapour density of $\frac{0.64 \times 10^6}{4 \times 10^6} = 0.16 \text{ g m}^{-3}$.

The pre-existing vapour density can be found from the surface conditions mentioned by Lee, temperature 23°C and dew point 13°C, giving a relative humidity of 53%. The saturation vapour density of water vapour at 23°C is 20.6 g m^{-3} so the actual vapour density is $20.6 \times 0.53 = 10.9 \text{ g m}^{-3}$.

Thus the additional water vapour from the straw burning is only 1.5% of that present beforehand, so for one fire it hardly matters. If however a whole area were under these fires (each taking say half an hour) and there were a light horizontal wind, so that a volume of air might receive an additional 1.5% of water vapour several times over, then the vapour from burning could become significant.

FH23

It is of interest to compare the addition of water by burning with that from evaporation, which from a dry stubble is about 1 mm of water a day, or 4 tons a day from an acre. The water from burning is only 1/6 of this. The burning produces water at a higher rate however, since it is concentrated into half an hour, while the evaporation is spread through the day.

REFERENCES

Lee, M.F. (1974). Cumulus cloud from a stubble fire. Weather 29, 102-103.

Ride, D.J. (1965). Convection from burning cornfields. Weather 20, 238-241.

Any comments on this paper should be sent to the author.

October 1979

Meteorological Office
Ministry of Agriculture, Fisheries and Food
Windsor House
Cornwall Road
HARROGATE
North Yorkshire HG1 2PW